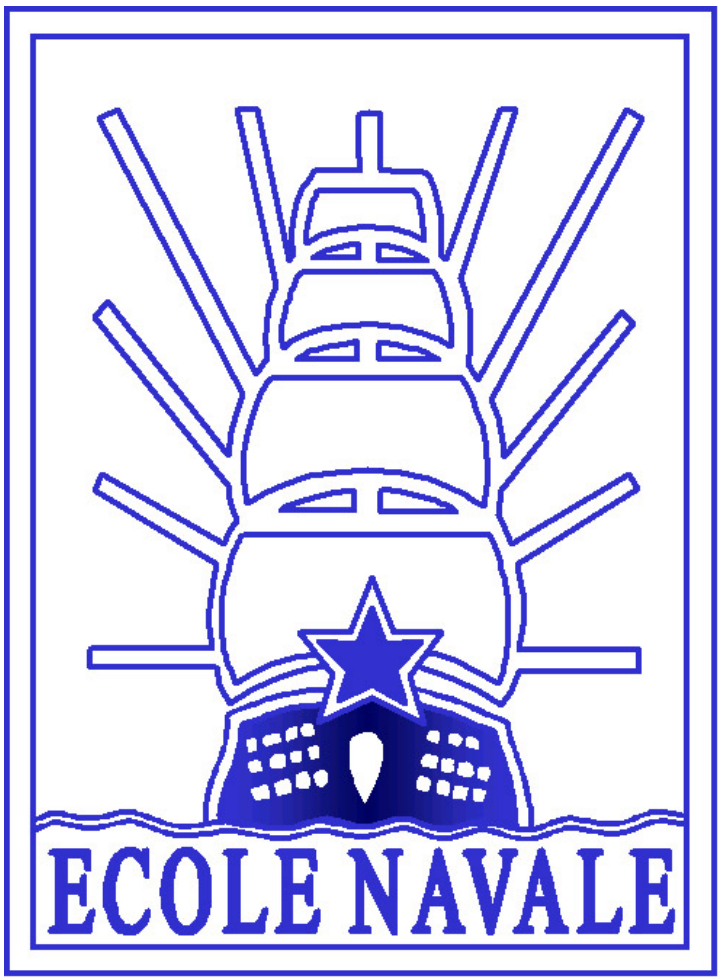
ECOLE NAVALE

EDUCATION DEPARTMENT

FOURTH SEMESTER

SCIENTIFIC TRAINING THROUGH IN-DEPTH UNITS
TRAINING OF THE EXECUTIVE OF THE NATION



HISTORICAL REVIEW OF THE DOCUMENT

Edition	Date	References	Evolutions	Performed by
1	01/10/05		First edition	

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[1] VA (voie d'approfondissement) = in-depth course

[2] SIM (systèmes informatiques et modélisation) = data processing systems and modelling

[3] GM (génie maritime) = maritime engineering

[4] ASM (acoustique sous-marine) = sub-marine acoustics
[5] GE (génie énergétique) = energy engineering

INTRODUCTION

1. GENERAL MATTERS

The fourth semester stretches from the end of semester 3 (close to the winter leave) to the summer leave at the end of July.

In the framework of their scientific training, cadets who integrated the engineering syllabus are directed on specific in-depth units depending both on their wishes and their results at their training options.

Cadets who integrated the professional master attend common training which enables them to validate the semester M1/S2 of the professional master "Maritime environment and naval operations".

The training objectives of this semester that is mainly dedicated to sciences are:

- To go thoroughly into scientific matters by attending proficiency courses (engineering);
- To go thoroughly into scientific matters issuing from specific fields (Professional master);
- To know the National Defence environment (participation in the Joint military academies seminar);
- To pass the 2nd level of the military English certificate;
- To go on with the maritime training;
- To get the J 80 skipper certificate.

2. ASSESSMENT

2.1. **Engineering syllabus**

Tests are concentrated on two periods for each in-depth unit. The first one is situated between winter and spring leaves, the second one between spring leave and the 14th July (French National Day). The in-depth units projects, which were carried out during the semester, are also part of the assessment scheme.

2.2. **Professional master syllabus**

Regulations linked to the professional master diploma impose a twofold control. The first one is a continuous control and the other one concern locked periods (1st session). It is also composed of a remedial session which takes part at the beginning of semester 5.

2.3. **Programme**

So as to balance the training on the whole semester and enable thus cadets to have a regular working rhythm, a ‘standard week’ system has been adopted. In this way, each week will be generally composed of 28 teaching units of academic courses shared out this way:

- Engineering training: 20 UI[6];
- Human and military training: 8 UI.

This standard week is made as follows:

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>H1</td><td rowspan="2">Human and military training</td><td rowspan="3">VA</td><td>VA</td><td rowspan="3">VA</td><td>VA</td></tr>
<tr><td>H2</td><td rowspan="2">Human and military training</td></tr>
<tr><td>H3</td><td rowspan="2">Sport</td><td rowspan="2">LV1 / LV2</td></tr>
<tr><td>H4</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>H5</td><td rowspan="4">VA</td><td>LV1 / LV2</td><td rowspan="4">VA</td><td rowspan="2">SPORT (OPTION)</td><td rowspan="2">VA</td></tr>
<tr><td>H6</td><td rowspan="2"></td></tr>
<tr><td>H7</td><td rowspan="2">SPORT (OPTION)</td></tr>
<tr><td>H8</td><td></td><td></td></tr>
</table>

[6] UI (unité d’enseignement) = teaching unit in hours

Nota bene:

- Some adaptations could occur for this sharing out depending on special circumstances (conferences,...).

- 23 slots per week are specially planned for in-depth units but on average, only 20 are actually used. This measure enables to have more flexibility for the courses given by external speakers.

- Until the TSGED (sport tournament gathering military Grandes Ecoles), Thursday afternoon's first course is dedicated to sport meetings. It also aims at optimising sport options training. Then, this **slot** is dedicated to LVE sessions (interviews with the Lieutenant in charge of the squad).

TRAINING PROGRAMME OF THE SEMESTER

	Subject	HO[7]	HNO[8]	Coeff.	ECTS
FMI[9]	In-depth unit	278		35	25
FMM[10]	Pre-corvette	35	3		/
	Corvette	70	48	7	
	Sailing		20		
FHM[11]	Joint military academies seminar (*SIGEM*)	70			/
	Conferences of general interest	4			
	Interview with the LVE[12]	12			
	Communication techniques	15		3	7
	English / 2nd modern language	40		3	
	English test	5			
	Leadership exercise on *land* (Barracuda)	21	27	*	/
	Infantry marches		15		
	Sport (by squad)	20		3	
	Sport (option)	24	30	1	
	Admiral running	6			
	Sport tournament (TSGED)	14	14		
Others	Study periods	26			/
	Public holidays	42			
	Traditions (*Grand C*)	7			
	Training for 8 May		8		
	Suppleness	35			
	TOTAL	**724**	**165**	**52**	**32**

* this coefficient is postponed to the 5th semester

Nota bene: Coloured modules are also part of the professional master syllabus.

[7] HO = Working hours
[8] HNO = Non-working hours
[9] FMI (Formation aux Métiers d'Ingénieur) = Engineering training
[10] FMM (Formation aux Métiers de Marins) = Seaman training
[11] FHM (Formation Humaine et Militaire) = Human and military training
[12] LVE (Lieutenant de Vaisseau d'Escouade) = Lieutenant who is in charge of a squad

TITLE I : SEAMAN TRAINING

1. OBJECTIVES

This training aims at keeping up as well as strengthening the learning acquired during the 1st and 3rd semesters of the training.

Navigation specific objectives are:

- acquisition of coastal navigation in every situation,
- introduction to ocean navigation,
- practice of tactics,
- to carry out manoeuvres,
- to get J 80 skipper certificate.

Ship specific objectives are:

- hydraulic systems study (helm),
- water-tightness basic knowledge (gland, lining),
- naval architecture elements,
- refrigerated energy (air-fridge and stores).

2. SUMMER CORVETTE

Cadets carry out a 2-week long corvette at sea. They have to perform at least **16** hours of watch-keeping in F1 (function one: watch-keeping officer with another team member) and also 4 hours in F1 on the simulator.
General objectives for this corvette are:

- navigation /manoeuvre: acquisition of coastal navigation and introduction to ocean navigation – tactics – manoeuvre;
- ship: production and distribution of electricity (production modes, network architecture,…) and navigation equipments (gyro compass, log, wind net and dead reckoning).

An official order paper provides the level of the cadets and details the objectives they have to reach for the next corvette.

3. PRE-CORVETTE

The summer corvette is preceded by a pre-corvette of one week.
During this period dedicated to seaman training, cadets are shared out into groups of 3 or 4; the 3 visual simulator bridges are prepared by 3 groups. The other groups alternate courses, stretch of water and radar simulator.
Some of the visual simulator slots are planned during non-working hours.
The objectives of the training on the visual simulator are the same as for the corvette CA1, that is to say a knowledge updating before boarding.
The objective of the training on the radar simulator consists in a navigation with mist.

The practical training for manoeuvre during this pre-corvette is the following:

PRACTICAL MANŒUVRE							
Code MANPRAT	**Title**	**UI**	**Group**	**Prof**	**Phase**	**Classroom**	**Obs.**
	Stretch of water BIM[13]/VSP/SAILING	8	Squad	Inst	PreCA2	PDE	

4. WEEK-END ON A CRUISER

A week-end dedicated to sailing on a cruiser is led by each squad in April and May. It consists in group navigation in the Iroise sea with mooring on the Saturday evening. It enables an acceleration of the training which is important to acquire the cruiser skipper certificate.

PRACTICAL MANŒUVRE							
Code MANPRAT	**Title**	**UI**	**Group**	**Prof**	**Phase**	**Classroom**	**Obs.**
	Sailing course	HNO	Class	DIRCOURS	Sailing WE	PDE	

[13] BIM = Training ship for manoeuvre

TITLE II : HUMAN AND MILITARY TRAINING

Within the framework of the extension of the training initiated in the previous semesters, the human and military training organised during the 4th semester aims at:

- developing thinking and synthesis capacities, written and oral expression;
- encouraging the improvement of linguistic skills;
- opening up cadets' mind on the Defence world and environment through the joint military academies seminar (*SIGEM*);
- developing personal endurance during marches and physical training.

EXPRESSION AND COMMUNICATION TECHNIQUES

1. OBJECTIVES

- Improve synthesis capacities;
- Develop the ability to talk and argue in front of the class with off-the-cuff speeches;
- Develop taste for reading and personal thinking and deepen general knowledge.

2. INITIAL PROGRAMME

ECM code	Course	Duration	Participants
9C	Presentation of suggested books	4 X 1	Class
3D	Synthesis paper: test	3	Class
4C	Synthesis marking	2	Class
19D	Oral presentations on the basis of the reading programme	5	Half of the class
20C	Debriefing on talks	1	Class
TOTAL		15	

Each cadet has to read the books and make then a presentation in front of a jury. The subject is given 20 minutes before the beginning of the presentation.

Themes and periods are changed every year.

INTERVIEW WITH THE LVE IN CHARGE OF THE SQUAD

Cadets benefit with their whole squad from an interview with the lieutenant in charge of their education and military training. This corresponds to 12 teaching units (about 1UI/week). The 4th semester goes on with thought dedicated to the following themes and interviews:

CODE	Presentation	UI
LVE	Command through concrete situations – qualities of a leader	7
	Discussion on a current topic	2
	Knowledge of the Navy	3
	TOTAL	12

PRATICE OF LANGUAGES : ENGLISH OR SECOND MODERN LANGUAGE

1. OBJECTIVES

Modern languages training is based on 40 UI.

English courses are only dedicated to cadets who have not reached the objective of the English CML2. Those must enable cadets to:

- gain autonomy, ease and correction in the practice of this language ;
- pass the CML1 at the end of the semester (S4) for the cadets who failed at the previous sessions;
- pass the CML2 at the end of the semester (S4) for those who already passed the CML1.

Cadets who passed the CML2 are only practising a second modern language (German, Spanish or Russian) instead of English.

2. INITIAL PROGRAMME

2.1. **English**

The trained skills are as follows:

- written comprehension;
- written expression;
- oral comprehension;
- oral expression;
- phonology;
- grammar.

2.2. **Second modern language**

Cadets who already passed the English CML2 can either go on with the practice of their 2nd modern language or choose a new one as a beginner :

- German, non beginner;
- Spanish, non beginner;
- Russian (beginners accepted under conditions).

Courses correspond to 4 UI per week, depending on the English courses calendar.

At the beginning of the semester, a test is put in place to check the level of cadets who registered at German or Spanish courses.

3. ASSESSMENT

3.1. **English**

Its goal is to evaluate the language mastering level in comparison with a given standard. To this aim, a common test for all the cadets is organised during the semester. It is based on three skills (oral comprehension, written comprehension, written expression).

3.2. **Second modern language**

Assessment is different for each group. Five fields are assessed under the following conditions:

Mark A	Mark B	Mark C	Mark E	Mark D
Oral comprehension	Written comprehension	Written expression	Grammar and lexical knowledge	Oral expression
Each mark will be based on at least two exams in class. Between 3 and 4 hours will be dedicated to this assessment.				This skill can be evaluated by an individual talk in front of the class.

The final assessment is composed of the average of these five marks and a written appreciation of the level reached by the cadet.

4. GUARDIANSHIP

Guardianship measures are going on for the cadets who have not reached yet the certificate's 1st level.

Two intensive training courses (one week) are put in place within the École navale at the beginning of the semester (during the joint military academies seminar) for the cadets who have continual difficulties to hit expected objectives.

Each training course is theoretically opened to eight cadets.

These training courses are largely based on the autonomous work of the cadets, either individual or through teams. The daily intervention of the teachers in charge of guiding and assessing the students makes it possible to give recommendations on the way students can improve themselves..

The list of the students that are concerned is suggested by the Languages Department.

Cadets who have failed at the English certificate's 1st level at the end of the 3rd semester will have to perform a **voluntary linguistic training period, outside the school, during the 4th semester.** They will be allowed to decide on its nature and its place but will have to pay for it. They will be able to do this training during February and Easter leaves or summer holidays. They have to report on their wishes to the lieutenant responsible for their squad.

MILITARY TRAINING

1. OBJECTIVES

The military training at semester 4 is composed of :

- hardening exercises : progressive programme of thematic marches;
- shooting: practice of shooting with infantry weapons whose aptitude certificates have already been acquired at the 1st semester.

2. INITIAL PROGRAMME

Three walks at night are organised within the general programme of marches of semester 3. Obstacles are also integrated into the marches base and a plastron is also provided by an external unit to animate a simple tactics theme. Marches won't end up after 01.00AM.
An adjustment of the following morning is to be found out:

- avoid tests and scientific courses as well as important conferences;
- favour subjects that make appeal to cadets' participation.

PRODEF CODE	Course	Teachers	UI	Observations	Group
5P	March theme 6	04 PRODEF	5 HNO	Within a 3-month slot. Return before 01.00AM	Class
6P	March theme 7	04 PRODEF	5 HNO		
7P	March theme 8	04 PRODEF	5 HNO		
8P	Training for the parade	PRODEF and DIRASPI	8 HNO	8 May Ceremony	Class
TOTAL			23 HNO		

To look for a time period (outside working hours) the days following the marches so as to clean up the guns.

LEADERSHIP TRAINING

1. OBJECTIVES

A leadership exercise on land (exercise Barracuda) goes on with the training which began with the first leadership exercise (Piranha at the second semester).

2. INITIAL PROGRAMME

This exercise stretches over 21 teaching units plus 27 non-working hours.

- *Observations* : this activity is organised under the form of an exercise occurring in a land environment. Cadets are shared out into groups. Each cadet takes the command of the group in turn. An executive plays the part of a supervisor in each group. Each group must integrate into a general plan coordinated by an exercise supervisor and reinforced by students exempt from this training.
- Detailed objectives:
    - Implement a directive leadership and a delegating leadership;
    - Take into account weather and topographic constraints;
    - Merge leadership skills as well as protection and defence knowledge;
    - To manage a unit which liaises between the groups and implement activities (exempts);
    - Work with other groups (work with people outside of the École navale, take into account others' constraints and adapt to them, know oneself to better work together for the mission achievement).

Nota bene: cadets' assessment for this exercise is taken into account at the fifth semester

JOINT MILITARY ACADEMIES SEMINAR

1. OBJECTIVE

A threefold objective :

- to make student officers understand right from the beginning of their training the complexity of the environment in which Defence evolves;
- to assert the joint nature of military action and thinking from the very beginning of the students' entry in the institution;
- to put in touch future Defence executives with national or international decision-makers of today.

2. INITIAL PROGRAMME

The joint military academies seminar (*SIGEM*) is organised in turn by one of the armies and takes place at the Military School, located in Paris (7th district).

The training consists in different elements:

- thematic round tables on diplomatic, juridical, financial, media, industrial and intelligence issues;
- institutional meetings (authorities of the State);
- informative visits;
- cultural and relaxation activities.

PHYSICAL EDUCATION

This semester is composed of a normal physical education programme performed by squad. These activities are no military exercises. This training also includes a physical training dispensed by sports option.

1. OBJECTIVES

- Develop physical capacities and particularly endurance.
- Develop motor skills that are specific to physical education .
- Get a significant level in a sports activity by means of the sports option training.
- Take part in the *T.S.G.E.D* which is a sport tournament gathering French military Grandes Ecoles each year.

2. INITIAL PROGRAMME

2.1. **Training by squad**

Based on 20 teaching units, physical training by squad is organised like follows:

- sports in teams (16 UI) ;
- assessment through the *pass'sport* tests (4UI).

2.2. **Training by sport option**

The training for optional sports activities is dispensed in accordance with the standard week schedule.

Optional sports activities that have been practised since the beginning of the 5th semester are assessed in February.

2.3. **Admiral running course**

Three running courses are organised at the Academy during this semester (total of 6UI).

TITLE III : ENGINEERING TRAINING

1. OBJECTIVES

As for the 3rd semester, the engineering syllabus and the master pro syllabus have 2 different types of training.

1.1. **Engineering syllabus**

This 3rd scientific stage enables cadets to get a specialisation basis in a very specific field thanks to a in-depth unit. The in-depth units constitute a logical consequence of options taught at the 3rd semester. Each option is a prerequisite for an in-depth unit.

During stage 3, engineers students from the EN choose an in-depth unit among the four indicated below:

- data processing systems and modelling (VA SIM);
- maritime engineering (VA GM);
- sub-marine acoustics (VA ASM);
- energy engineering (VA GE).

The sharing-out of these courses depends on cadets' wishes, the necessity of well-balancing the groups and the results at the optional subjects.

These courses are completed by a compulsory module made of the in-depth unit project.

1.2. **Professional master syllabus**

Stages 2 to 4 of the auditor syllabus are now part of the programme of the professional master "Maritime environment and naval operations" of the École navale.

Gathered in teaching units, this 3rd stage of scientific training enables the cadets to complete their learning in the fields which was already initiated during the second stage:

- naval energy;
- naval hydrodynamics;
- digital filters and naval applications;
- geographic information systems.

These courses are completed by a compulsory module made of the speciality project.

2. TRAINING DESCRIPTION

2.1. **In-depth unit**

Each in-depth unit corresponds to 216 teaching units shared out into theoretical modules (24 UI on average including 2UI of tests).

Training in each module is divided into courses, conferences, tutorials and practical.

2.2. **Professional master teaching units**

Training contains10 courses modules are the subject of a continuous assessment and a written examination at the end of the semester. Training also includes a programme of industrial conferences on "Routing expert systems" (12h).

2.3. **Project**

In parallel with in-depth or teaching units, students have to put in place an in-depth unit project (engineering) or a speciality project (auditor). 48 UI are dedicated to the in-depth unit project. The last six hours are used for the oral presentations.

Engineering syllabus

In-depth unit "Computer systems and modelling"

VA SIM1– OBJECT-ORIENTATED TECHNOLOGY 1 (C++, UML)

Department: Computer science
Prerequisite courses: Computer science option (Module 1)
Courses or Modules for which this module is necessary: VA SIM6, 8
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Introduction to object-orientated technologies: concepts, visual C++ programmation and UML modelling.

Students know-how at the end of the courses:

Students will master object-orientated paradigms: classes, polymorphism, inheritance… Those ones will have been used through Visual C++ language. Other advanced concepts from C++ language, such as patterns must be known. Finally, the students will acquire UML modelling basic knowledge. They will have used it thanks to the workshop dedicated to the enginnering software "objecteering".

Connections with other courses:

This course gives an overview of object-orientated languagues power in comparison with procedural languages studied during the first year. Object-orientated programming and modelling are used again for tutorials of the in-depth course other modules and also for the in-depth unit project.

2. DETAILED PROGRAMME

1. Object-orientated paradigms (1h C[14])
2. Classes (1h C and 3h TD[15])
3. Objects tables and operator surdefinition (1h C and 3h TD)
4. Inheritance and access control (1h C and 4h TD)
5. Patterns, STL and name spaces (1h C and 4h TD)
6. UML modelling (1h C and 2h TD)

[14] C = Course

[15] TD = Tutorial

VA SIM2– OBJECT-ORIENTATED TECHNOLOGY 2 (JAVA)

Department : Computer science
Prerequisite courses: Computer science option (Module 1)
Courses or Modules for which this module is necessary : VA SIM5
Number of ECTS credits :1,5

1. COURSE OBJECTIVE

Introduction to the Java language and application of object-orientated concepts through the use of components stores (*API*)

Students know-how at the end of the courses:

Cadets will have studied a second object language. They will have gone thoroughly into object concepts through Java components stores (multithreading, polymorphisms by interfaces, graphic interfaces design). The design by component approach enables to make students familiar with the developing of programmes through the assembling of existing software bricks.

Connections with other courses:

This course complete the one on object-orientated technoloy 1 . It enables cadets to compare the two main object languages (Java and C++) and thus to better assimilate object-orientated concepts . These two types of languages are very often used during in-depth unit projects and final studies projects.

2. DETAILED PROGRAMME

1. Java fundamental principles (1h C + 2h TD)
2. JDK and its tools (2h C + 2h TD)
3. Swing : graphic interfaces in Java (2hC + 4h TP[16])

[16] TP = Practical

VA SIM3– DATA PROCESSING SECURITY AND CRYPTOLOGY

Department : Computer science
Prerequisite courses: Computer science option (Module 3)
Courses or Modules for which this module is necessary : None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course presents data processing security in a general context. After a presentative of the objectives of the data processing security, another part will be devoted to the means of action for implementing a safe environment (cryptography and network).

Students know-how at the end of the courses:

Students will have understood the full details of data processing security in a military context. They will have a sufficient knowledge to identify and take into account the threat.

Connections with other courses:

Students have studied computer networks and security at the module 3. This course aims at highlighting threats on computer systems and also presenting the appropriate protections.

2. DETAILED PROGRAMME

1. Introduction to Data Processing Security (6 h C)
2. Means of action for data processing security (4 h C)
3. Cryptography fundamentals (6 h C + 2h TD)
4. Assessed practical (3 h TP)

VA SIM4– GEOGRAPHIC INFORMATION SYSTEMS

Department : Computer science
Prerequisite courses: Computer science option (Module 2)
Courses or Modules for which this module is necessary : VA SIM9
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course constitutes an introduction to geographic information systems principles. Tackled issues concern all the stages of geographical data processing and analysis, from acquisition techniques to chart processing techniques. These theoritical aspects are completed by a practical exercice on a software dealing with geographic informations sytems.

Students know-how at the end of the courses:

At the end of this course, young officers will know how to grasp the role and potential of geographic information systems, especially in the context of their future carrier, in which geographic information is a main element.

Connections with other courses:

It represents an important preparation stage for a various number of final studies projects.

2. DETAILED PROGRAMME

1. Geographic information acquisition techniques (satellite, aerial photo, GPS, sonars).

2.Quality of geographic data and mistakes processing.

3. Spatial data structures (raster versus vector).

4. Techniques for questioning and analysing spatial data.

5. Mapping principles.

6. Study case (4-hour project).

7. Laboratory: practice of "Arc View", a software on geographic information systems, on the basis of some geographic data processing scenarios.

VA SIM5 – EMBEDDED AND DISTRIBUTED SYSTEMS

Department: Computer science
Prerequisite courses: Computer science option (Module 3) – VA SIM1
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The objective of this course is to make cadets aware of the distributed management of information, of the issue of realising different tasks in parallel as well as the real-time information management.

Students know-how at the end of the courses:

Students will have understood distributed systems principles. They will have carried out programmes gathering light processes (Thread en Java) and will have written applications distributed in Remote Method Invocation.

Connections with other courses:

This course relies on Java courses and it also uses security and networks courses.

2. DETAILED PROGRAMME

1. Introduction to distributed systems.
2. Competition between processes.
3. Mutual exclusion.
4. DCE (Distributed Common Environment) standard.
5. Control of the competition by the signal stations.
6. Synchronization through messages.
7. Introduction to real-time data processing.
8. Context and applications.

VA SIM6 – COMPUTER GRAPHICS

Department: Computer science
Prerequisite courses: VA SIM1
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Give cadets a graphic computing basis. Students are made aware of modelling techniques and spatial objects display.

Students know-how at the end of the courses:

Students will know how to retranscribe the 3D scenes design process and their 2D projection (screen display). Concerning scenes design, students will have studied 3D objects modelling, the various geometric transformations and the lighting processes. As for display, they will have learned the different projection modes (perspective and parallel), clipping algorithms, lines design, polygons padding as well as algorithms dedicated to hidden parts deletion. Those concepts will have been illustrated by tutorials in C/C++ language (by using OpenGL graphic library).

Connections with other courses:

Connections will be set up with virtual reality modules and geographic information systems (complementarity of these three courses, scenes and data files importation and exportation)

2. DETAILED PROGRAMME

1. 2D geometry, 2D transformation and graphic primitives.
2. OpenGL, 3D geometry, 3D transformation, scenes graphs.
3. Curbs, surfaces and lighting.
4. Coulour and texture, hidden parts deletion.
5. Practical.

VA SIM7 – SIMULATION AND ARTIFICIAL INTELLIGENCE

Department: Computer science
Prerequisite courses: VA SIM1
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Introduction to multi-agents systems principles and genetic algorithms as modelling and simulation tools.

Students know-how at the end of the courses:

At the end of this course, students will have modellised complex systems thanks to multi-agents systems. They will have gone thoroughly into multi-agents systems and will have handled such systems with the help of the "Netlogo" package software in the framework of simulation exercises. In addition, they will be able to solve multicriteria optimization problems thanks to genetic algorithms.

Connections with other courses:

This course uses C++ language for tutorials dedicated to genetic algorithms.

2. DETAILED PROGRAMME

1. Introduction to complex systems modelling.
2. Multi-agents models principle.
3. Multi-agents models applications (use of the Netlogo package software).
4. Genetic algorithms: principle and application (use of C++).
5. Project (Study case).

VA SIM8 – VIRTUAL REALITY

Department: Computer science
Prerequisite courses: VA SIM6
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course is an introduction to the virtual reality concept. It presents its applications, the means that are employed to immerse users in a 3D world and the possible interactions.

Students know-how at the end of the courses:

At the end of this course, students will have an overview of virtual reality. They will know standard applications (civilian and military), possibilities for practical configurations and the possible interactions between mankind and machines.

Connections with other courses:

This course uses concepts studied during the course dedicated to computer graphics, especially the immersion in 3D worlds. It also uses the interaction part of the simulation and artificial intelligence course.

2. DETAILED PROGRAMME

1. Application of virtual reality (industrial needs and simulation, immersive scientific display).
2. Material configurations in the field of virtual reality.
3. 3D virtual worlds and digitization for virtual reality.
4. Interactions (moving, selection and handling, application control).
5. Application with “OpenMASK” (Modular Animation and Simulation Kit).
6. Simulation and virtual reality in the armies.

VA SIM9 – REMOTE SENSING

Department: Computer science
Prerequisite courses: VA SIM4
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Introduction to remote sensing as well as its techniques for getting satellite images. Image processing and information extraction principles.

Students know-how at the end of the courses:

Students will be aware of general principles linked to satellite images acquisition, computer processing, spatial analyses as well as the interpretation of the spotted phenomena issuing from the different analyses. Students will have handled some satelitte images on different image processing modules of the "IDRISI" software.

Connections with other courses:

Especially with the course on geographic information systems concerning the problem of integrating satellite images in various geographic information systems. It also concerns the supply of methods (used for geographic information systems) in the images spatial analysis.

2. DETAILED PROGRAMME

1. Spectral perception of spatial objects.
2. Spatial and temporal perception of spatial objects.
3. Image data in remote sensing.
4. Information extraction.
5. Image and spatial analysis in geographic information systems.
6. Satellite image data processing via the software "IDRISI".

VA SIM10 – IN-DEPTH UNIT PROJECT

Department: Computer science
Prerequisite courses: VA SIM1,2
Courses or Modules for which this module is necessary: Final studies project
Number of ECTS credits:

1. COURSE OBJECTIVE

This activity (performed by groups of 2 students) is a good way for preparing to final studies project. It also brings an additional personal training on a theme of their choice.

2. DETAILED PROGRAMME

42 teaching units are dedicated to the in-depth unit project. Assessment is composed of a written paper and an oral presentation in front of a jury (6 UI).

In-depth unit "Maritime engineering"

VA GM1 –FLUIDS/STRUCTURE INTERACTION

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The fluids-structure interaction is one of mechanics' main fields. It deals both with a structure's movement and the one of the fluid that surrounds it. The objective of this course is to make students aware of this aspect of mechanics to enable them to better grasp manoeuvrability course on naval hydrodynamics and to give them theoretical and empirical methods so as to deal with a problem (submarine manoeuvrability, platform movement, elastic distortion).

Students know-how at the end of the courses:

In this course, the first part concerns the main factors of a fluids-structure interaction problem and also the associated rough estimates. The 2nd part is dedicated to techniques enabling to integrate the surrounding fluid effect when a structure is moving but not permanently. Two aspects are approached. The first one deals with the non-stationary movement in a fluid of a solid that cannot be distorted. The other one concerns the vibration setting up of simples structures (girders and plates) and indicates methods that determine vibration natural frequencies by taking into account the effects of the surrounding fluid.

Connections with other courses:

This course is linked to naval hydrodynamics courses.

2. DETAILED PROGRAMME

1. Introduction.
2. Dimensional analysis of a fluids/structure interaction problem.
3. Case of rigid solid bodies that are in motion in a fluid (Phenomenology - Potential theory and added weight - Sections (bidimensional body) - Tridimensional body - Bands theory).
4. Case of structures that can be distorted when exposed to dense fluids (girders - vibrating plates).

VA GM2.1 – HYDRODYNAMICS OF THE FOIL

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: VAGM2.2. et VAGM3
Number of ECTS credits: 0,5

1. COURSE OBJECTIVE

Highlight the complexity of flows around bearing areas. Phenomenological analysis and establishing of hydrodynamic coefficients.

Students know-how at the end of the courses:

Students will have to know what the stresses on a foil set in a fluid in motion are.

Connections with other courses:

This course is necessary for VAGM2.2. et VAGM2.3 courses.

2. DETAILED PROGRAMME

Courses : 4 UI
Tutorials: 2 UI
Tests: 1 UI (common with VA GM2.2.)

1. Introduction to streamlined bodies.
2. Hydrodynamic coefficients establishing.
3. Reynolds and containment effect.

VA GM2.2 – CAVITATION PHENOMENOLOGY

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: VAGM3
Number of ECTS credits: 0,5

1. COURSE OBJECTIVE

Definition of the cavitation concept. Application to bearing areas and screws.

Students know-how at the end of the courses:

Capacity to highlight constraints linked to screw manufacture and functioning and to take into account harmful effects of the cavitation form and characterization.

2. DETAILED PROGRAMME

Courses: 4

Tutorials: 2

Tests: 1 (common with VA GM2.1)

1. Definition.
2. Dynamics of cavitation bubble.
3. Cavitation forms.
4. Application to the screw.

VA GM3 – STRUCTURE – MILITARY NAVAL ARCHITECTURE

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This module aims at acquiring a procedure permitting to conceive and lay out a ship structure in its environment.

Students know-how at the end of the courses:

To know the various principles and criteria that are necessary to lay out a military naval structure.

2. DETAILED PROGRAMME

Courses: 22 UI

Practical: see VA GM10

Tests: 2 UI

1. Reminders on materials' resistance (girders in traction-bending).
2. Design of surface ships and submarines structures.
3. Introduction to military naval architecture:
   - Naval architecture project.
   - First step of the lay-out.
   - Military environment (vulnerability to military assaults).
   - Presentation of ship projects.
4. Materials : General matters (choice criteria, overview of naval steels).
5. Structures dynamics:
   - Modal analysis (specific modes and frequencies).
   - Fast dynamics (effects of aerial and submarine explosions).

Tutorial : materials resistance and naval architecture.

VA GM4.1 – NAVAL HYDRODYNAMICS (HEAD RESISTANCE)

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

This course gives a presentation of theoretical, digital and experimental approaches of the ships ' head resistance.

Students know-how at the end of the courses:

Students will be able to evaluate and anticipate the waves drag and frictional resistance of an underwater hull thanks to models and charts.

2. DETAILED PROGRAMME

Courses: 11 UI

Practical: see VA GM10

Tests: 2 UI

1. Modelling of a drag problem.
2. Waves drag: modelling and digital approach.
3. Frictional resistance: modelling and digital approach.
4. Extrapolation experimental methods.

VA GM4.2 – NAVAL HYDRODYNAMICS (PROPULSION)

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

This module aims at acquiring naval hydrodynamics principles that are useful to lay out the propelling system of a ship in its environment.

Students know-how at the end of the courses:

This course presents experimental and theoretical approaches of a ship propulsion.

Connections with other courses:

This course will enable student officers taking part in the in-depth unit "Maritime engineering" to acquire a basic knowledge of approaches that are used to lay out the propelling system of a ship in the framework of a "ship project".

2. DETAILED PROGRAMME

Courses : 12 UI

TP : voir VA GM10

Tests : 2 UI

1. Bearing outline.
2. Screw: experimental approach.
3. Screw: theoretical approach.
4. Swell run off in perfect fluid – 3D integral methods.

VA GM5.1 – NAVAL HYDRODYNAMICS (SWELL AND WAVES)

Department: Mechanics – energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

This courses aims at providing basic knowledge of sea phenomena on open channels.

Students know-how at the end of the courses:

At the end of the course, students are required to know main phenomena linked to swell and waves.

Connections with other courses:

Prerequisite: general courses on fluids mechanics.

2. DETAILED PROGRAMME

Courses: 11 UI
Practical: see VA GM10
Tests: 2 UI (common with VA GM 5.2)

1. Equations of problems linked to open channels in perfect fluid.
2. Swell.
    - Sinusoidal swell or 1st-rate swell (Swell of Airy).
    - Towards the real swell: Swell of Stokes, waves breaking, bathymetric effects, wave diffraction, synthesis of swell models, viscous effect, interaction between swell and current.
    - Passing swell.
3. Waves.
    - Short-term and long-term statistical approach.
    - "Wave to wave" description.
    - Spectral description of the wave edge.
    - Statistic features of sea states.
    - Standardized spectra.
    - Multidirectional wave edge.
    - Long-term approach: atlas of sea states.

VA GM5.2 – NAVAL HYDRODYNAMICS (SHIP HOLDING AT SEA)

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

This module deals with the behaviour of a ship with swell and on rough sea. The linear model, useful for phenomena understanding is used as a basis for the presentation and description of real phenomena that can be observed and also for all the movements. This course is extended by the long-term statistical approach of the ship's operational efficiency, useful for its management. It is also made of an introduction to the impact of ship holding on the naval architecture.

Students know-how at the end of the courses:

At the end of this course, students are required to have a basic knowledge of the behaviour of a ship at sea to be well-prepared for real operations at sea and to grasp the typical documents of a ship.

Connections with other courses:

Necessary courses: courses related to swell and waves.

2. DETAILED PROGRAMME

Courses: 19 UI
TP : voir VA GM10
Tests : 2 UI (commun avec VA GM 5.1)

1.Equations of ship's movement on swell.

2.Linearised approach

Linearisation of equations for solid and temporal elements – Reminders on the linear filter – Problem of diffraction-radiation in frequential – The ship filter – Linear coefficients of 2nd order – The slender ship

3. Behaviour with real swell

The surging system, heaving, pitching – The lurch, rolling and yaw system – Navigation with a astern sea - Navigation with sidelong sea - Stabilisation

4. Operational efficiency

Assessment of a ship's operational capacities - OTAN criteria – Operability index

5. Hull drawing

Effects of the dimensions and form of an underwater hull on movements – Underwater hull's optimal coefficients.

VA GM6.1 – NAVAL HYDRODYNAMICS (MANOEUVRABILITY)

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

The objective of this module is to acquire naval hydrodynamics principles that are useful to plan a ship manoeuvrability in its environment.

Students know-how at the end of the courses:

This course provides an overview of experimental and theoretical approaches of a ship manoeuvrability.

Connections with other courses:

This course will enable student officers belonging to the in-depth unit "Maritime engineering" to acquire a basic knowledge concerning approaches that are used to analyse a ship manoeuvrability in the framework of a "ship project".

2. DETAILED PROGRAMME

Courses: 15 UI

Tutorials: 1 UI

Practical: see VA GM10

Tests: 2 UI

1. Introduction.
2. Manoeuvrability

VA GM6.2 – SHIP PROJECT

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 0,75

1. COURSE OBJECTIVE

The objective of this course is to cover all the aspects of the design loop of a ship. The engineering approach of complex technical and sociological systems is implemented within the "PrISM" expert system. This system will enable students to fully conceive their own ship model (forms plan, fittings, weight estimate, stability, propulsion, ship holding at sea, structure) and to set it in real navigation conditions thanks to weather models that are downloaded in real time. At the end of a design loop, students will be able to quantify the operational capacities of ship models during the landing of aircrafts with a rough sea.

Students know-how at the end of the courses:

This course presents the system-engineering approach applied to the ship design project. It also deals with the importance of the human factor for the design of a ship in the framework of the optimization of a navigation with various constraints.

Connections with other courses:

This course constitutes a synthesis of all naval engineering courses that have a "system" approach.

2. DETAILED PROGRAMME

Courses: 12 UI
Test: 0 UI

1. General staff objectives.
2. Design of the forms Plan.
3. Fittings, CPE.
4. Weight estimate.
5. Calculation of the static stability module, GZ curb design, standardization of the ship (BV standards).
    - modal analysis (specific modes and frequencies).
    - fast dynamics (effects of air and submarine explosions).

VA GM7 – INSTRUMENTATION AND TSD

Department: Mechanics - energy
Prerequisite courses: Mechanics option – TC4
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course deals with the instrumentation onboard Navy's ships. Different measuring techniques used on bridge and for propulsion are approached during the course. For example: measuring principle, precision, sensibility and influence magnitude of used sensors and also the precautions that have to be taken. In the framework of this course, statistical processing techniques are also dealt with. Students are especially made aware of convergence criteria of an average and a standard deviation and they are provided with statistical tests tools in order to detect measuring mistakes.

Students know-how at the end of the courses:

At the end of this course, students are expected to know the basic functioning of the main part of onboard instrumentation, to be conscious of the necessity of maintaining onboard sensors and to know what the onboard instrumentalists' job consists in.

Connections with other courses:

This course takes place after the 1-st year course entitled "Measure and Sensors". It insists on the applications of Navy's different measuring methods. Emphasis is also placed on measuring methods linked to outflows and statistical methods related to data processing, which could be useful for final studies projects.

2. DETAILED PROGRAMME

Courses: 14 UI
Tutorials: 8 UI
Practical: see VA GM10
Tests: 2 UI

1. Measuring chain.
2. Instrumentation for propulsion monitoring.
3. Bridge instrumentation.
4. Instrumentation for fluids mechanics.
5. Data acquisition and transfer.
6. Statistics (assessment, convergence of estimation systems and abnormal groups testing).

VA GM8 – DIGITAL METHODS IN NAVAL HYDRODYNAMICS

Department: Mechanics – energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 2

1. COURSE OBJECTIVE

The objective of this module is to acquire the basic learning necessary to solve physical problems. This includes the help of models requiring the implementation of digital methods. The course approaches various digital methods that must be part of the engineer's knowledge: it goes gradually from basic methods to those providing solutions to differential equations and equations with partial derivatives. The chosen approach underlines the main difficulties that can be met when you want to solve a naval hydrodynamics problem by a digital approach. Those digital techniques are then applied to the projection of foils preformance and sea screws.

Students know-how at the end of the courses:

At the end of this course, students will have acquired the basic knowledge that is necessary to solve a problem by a digital approach. In particular, they will be able to provide their own analysis on simulations results in the field of naval hydrodynamics.

Connections with other courses:

This course is aimed at student officers who have a mechanics knowledge in the field of fluids. It will also easy the use of digital methods in future projects (VA GM and final studies projects). Moreover, it will enable the future engineer, beyond his initial training, to display good judgement regarding digital results issuing from models, softwares and simulations.

2. DETAILED PROGRAMME

Courses: 22 UI

Practical: 4 UI

Tests: 2 UI

1 Operating systems.

2 Unix system.

3 Programming.

4 Introduction to digital methods for physics.

5 Algebraic systems.

6 Tools: interpolation, smooting, approximation, derivation, integration.

7 Differential equations.

8 Equations with partial derivatives.

9 Digital methods for fluids mechanics; application to foil and screws.

VA GM9 – VA GM PROJECT

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 4

1. COURSE OBJECTIVE

This activity, performed by groups of 2 students enables them to prepare for their final studies project and it also provides them with an additional personal training on a subject of their choice.

2. DETAILED PROGRAMME

Practical: 42 UI for the project
Tests: 6 UI for the oral presentations

VA GM10 – PRACTICAL

Department: Mechanics - energy
Prerequisite courses: Mechanics option
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This activity, performed by groups of 2 students enables them to apply, through 6 Practical, the learning acquired in the framework of the VA GM.

2. DETAILED PROGRAMME

Practical: 21 UI
Tests: report

1. Study of potential outflows around outlines (theoretical approach and simulations).
2. Digital simulation of gravity waves (tests concerning different digital schemes: precision, stability and factors testing: no space, no time).
3. Simulations of a run off around a 2D outline with the "Fluent" software (calculation of the pressure on the outline, calculation of the lift coefficient, tests for different flows speeds and different angles of incidence of the outline). Simulations of a run off around a 2D outline with the "Xfoil" software (stress establishing).
4. Study of a vibrating plate (theoretical approach, simulations and handling).
5. Study of a transducer response (sensing with sonar antennas in a pool and measuring of their directivity).
6. Study of stability of a ship (stability measures carried out on scale model in a pool).

In-depth unit "Sub-marine acoustics"

VA ASM1 – INITIATION INTO THE SOFTWARE “MATLAB”

Department: Signals and acoustics
Prerequisite courses: None
Courses or Modules for which this module is necessary: VA ASM 2, 3, 4, 5, 7, 8
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The objective of this course is to initiate the cadet into matrix programming by using the "Matlab" software. After a short introduction, exercices with a growing level of difficulties will be set. Students will be able to achieve them thanks to a course support. The 1st sessions concern the experiment of main tools (matrix and vector calculus, graphs, loop for, condition if, saving, functions, data files opening and closing). Then, direct applications of signal processing courses will be set (Fourier integral, introduction to spectral analysis, screening, ...). Exercices on image processing will close the course.

Students know-how at the end of the courses:

Students must be able to work out a simple programme containing condition loops, graphs displays, functions signals and data saving. The programing of a Fourier integral must be mastered as well as the use of help windows.

2. DETAILED PROGRAMME

Courses: 4 UI
Tutorials: 18 UI
Tests: 2 UI

1. General presentation.
2. Data type and graphic illustration.
3. Scripts and functions.
4. Data files.
5. Applications.

VA ASM2 – RANDOM SIGNALS

Department: Signals and acoustics
Prerequisite courses: TC 8 (BTS) – VA ASM1
Courses or Modules for which this module is necessary: VA ASM 5, 7, 8
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Signal always appears as a mix of a useful part and a disturbing noise. Its nature gives it thus a random aspect. After a reminder concerning the bases of probability theory and statistic features of random variables , the objective of the course is to bring in the description of random signals that either contain information to be transmitted or represent interferences. This course is essentially dedicated to features of secondary importance and that are most of the time described by the correlation function or spectral density.

Students know-how at the end of the courses:

Cadets must be able to recognize a random process (in particular stationary and of secondary importance) and to assess a certain number of factors.

2. DETAILED PROGRAMME

Courses: 12 UI

TD: 10 UI

Tests: 2 UI

1. Probability theory.
2. Random process.
3. Random processes screening.

VA ASM3 – SUBMARINE ACOUSTICS

Department: Signals and acoustics
Prerequisite courses: Propagation (O3M1)
Courses or Modules for which this module is necessary: VA ASM 5, 9
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The objective of this course is to study the characteristics of the propagation of sound in the ocean. After describing the ocean from the acoustic point of view, two features are studied in detail: modes of propagation of sound in the ocean and then target indexes.

Students know-how at the end of the courses:

Cadets must understand the modes of propagation of sound in the ocean and the projection of obstacles spreading or reflexion indexes.

2. DETAILED PROGRAMME

Courses: 12 UI

Tutorials: 7 UI

Practical: 3 UI

Tests: 2 UI

1. Acoustic description of the ocean.
2. Reflection and diffusion.
3. Spreading.

VA ASM4 – DETECTION - ASSESSMENT

Department: Signals and acoustics
Prerequisite courses: VA ASM 1
Courses or Modules for which this module is necessary: VA ASM 9
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The aim of this course is to establish sensing and assessment theoretical bases that are necessary for the applications to telecommunications as well as Radar and Sonar sensing systems.

Students know-how at the end of the courses:

Students must be able to solve problems linked to binary sensing (presence ou absence of a target) and assess the corresponding factors (speed, course,...).

2. DETAILED PROGRAMME

Courses: 11 UI

Tutorials: 8 UI

Practical: 3 UI

Tests: 2 UI

1. Hypothesis test.
2. Signal sensing.
3. Factors assessment.
4. Signal assessment.

VA ASM5 – ELECTROACOUSTICS

Department: Signals and acoustics
Prerequisite courses: Spreading (O3M1), VA ASM3
Courses or Modules for which this module is necessary: VA ASM 9
Number of ECTS credits: 15

1. COURSE OBJECTIVE

The objective of this module is to know and understand transducers that are used in submarine acoustics. After a presentation of physical principles that are used for sound waves generation in the sea environment, stress will be laid on the description and characterisation of the different sensors used in submarine acoustics. Finally, transducers modelling will also be presented as well as the measuring and integration of these sensors.

Students know-how at the end of the courses:

Cadets must have understood basic functioning of classical transducers that are used in submarine acoustics and the way they can be integrated into a measuring chain.

2. DETAILED PROGRAMME

Courses: 6 UI

Tutorials: 5 UI

Tests: 1 UI

1. Generation principles of sound waves.
2. Transducer modelling and features.
3. Types of transducers in submarine acoustics.
4. Measure, processing and implantation.

VA ASM6 – SPECTRAL ANALYSIS

Department: Signals and acoustics
Prerequisite courses: BTS (TC8), TNS (O3M2)
Courses or Modules for which this module is necessary: VA ASM 9
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The aim of this module is to presente and compare different techniques for the assessment of signal spectra. After a presentation of the classical methods (correlogramme et spectrogramme), stress will be laid on auto-regressive methods. Finally, high resolution techniques will be explained.

Students know-how at the end of the courses:

Students must know conventional methods for assessing signals spectra: principles, hypotheses, bias, variance, etc...

2. DETAILED PROGRAMME

Courses: 11 UI

Tutorials: 8 UI

Practical: 3 UI

Tests: 2 UI

1. Introduction and correlogramme.
2. Spectrogramme.
3. Auto-regressive modelling.
4. Introduction to high resolution methods.

VA ASM7 – DIGITAL COMMUNICATIONS

Department: Signals and acoustics
Prerequisite courses: BTS (TC8) – TNS (O3M2) – VA ASM1, 2
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course aims at providing bases that permit to understand current digital communication techniques. It deals with data source encoding (so as to reduce outputs), channel encoding and the associated transmission techniques. It also approaches reception systems that are implemented to reduce mistakes possibilities and improve data recovery before the decoding.

Students know-how at the end of the courses:

Cadets must know the transmission chain principle as well as the structure of the different functions of the transmitter, the channel and the receiver. Finally, basic techniques linked to transmission will have to be acquired.

2. DETAILED PROGRAMME

Courses: 12 UI

Tutorials: 12 UI

Tests: 2 UI

1. Transmission chain principle.
2. Baseband transmission techniques.
3. Carrier transmission techniques.

VA ASM8 – IMAGE PROCESSING, FORMS RECOGNITION

Department: Signals and acoustics
Prerequisite courses: BTS (TC8) – TNS (O3M2) – VA ASM1
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To assimilate conventional techniques for image processing (limited to "low level" processing, i.e. screening and segmentation by regional and border approach). To teach basic methods linked to forms recognition.

Students know-how at the end of the courses:

Students must master basic tools of image processing and understand mechanisms that manage forms recognition.

2. DETAILED PROGRAMME

Courses: 12 UI

Tutorials: 4 UI

Practical: 6 UI

Tests: 2 UI

1. Introduction.
2. Images screening.
3. Segmentation.
4. Forms recognition.

VA ASM9 – SONAR

Department: Signals and acoustics
Prerequisite courses: VA ASM1, 3, 4, 5, 6
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The objective of this module is to integrate most of the concepts which were studied during the in-depth unit into the presentation and understanding of various sonar systems. The final objective is to be able to set out and solve the sonar equation in a given system.

Students know-how at the end of the courses:

Students mustbe able to set out and solve the sonar equation for different applications (active, passive, fishing, minehunting,...).

2. DETAILED PROGRAMME

Courses: 9

Tutorials: 10

Practical: 3

Tests: 2

1. Presentation of the various sonar systems.
2. Antenna processing.
3. Sonar systems architecture.
4. Sonar equation.

VA ASM10 – VA ASM PROJECT

Department: Signals and acoustics
Prerequisite courses: VA ASM1, 3, 4, 5, 6
Courses or Modules for which this module is necessary: None
Number of ECTS credits:

1. COURSE OBJECTIVE

In-depth unit projects are supervised by the different members of the Signals and Acoustics Department.

2. DETAILED PROGRAMME

Tutorials: 42 UI for the project
Tests: 6 UI for oral presentations

VA ASM11 – ALTERNATING PRACTICAL

Department: Signals and acoustic
Prerequisite courses: VA ASM1, 3, 4, 5, 6
Courses or Modules for which this module is necessary: None
Number of ECTS credits:

1. COURSE OBJECTIVE

   3 alternating practical activities are put in place: one concerns automatics and the others are linked to submarine acoustics.

2. DETAILED PROGRAMME

   Practical: 9 UI

VA ASM12 – SEMINAR ON SUB-MARINE ACOUSTICS

Department: Signals and acoustics
Prerequisite courses: VA ASM1, 3, 4, 5, 6
Courses or Modules for which this module is necessary: None
Number of ECTS credits :

1. COURSE OBJECTIVE

This seminar deals with the following topics:

- Radar ;
- Kalman screening (Course + Practical) ;
- HF sonars (high frequencies) and minehunting.

2. DETAILED PROGRAMME

Courses: 17 UI

Tests: 0 UI

In-depth unit: "Energy engineering"

VA GE1 – NUCLEAR

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know nuclear physics bases so as to understand how reactors function.

Students know-how at the end of the courses:

See course objectives.

Connections with other courses:

This course is planned for the beginning of the semester and belongs to the modules group entitled "Energy sources". It approaches the synthesis part of the module "Assessment of energy chains".

2. DETAILED PROGRAMME

Courses: 14 UI

Tutorials: 8 UI

Practical: 3 UI

Tests: 2 UI

1. Introduction : the nuclear issue.
2. Reminders on material’s structure.
3. Radiation : radioactivity.
4. Interaction between radiation and material; sensing.
5. Nuclear reactors physics: neutrons; fission (fusion); reactors principles.
6. Nuclear reactors technology.

VA GE2 – COMBUSTION

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know combustion bases and the main applications.

Students know-how at the end of the courses:

This course provides general knowledge on combustion main processes and their involvement in the production of energy.

Connections with other courses:

This course is part of the modules group "Energy sources". It is also associated to "Turbo-driven machines" and "Assessment of energy chains" modules.

2. DETAILED PROGRAMME

Courses: 14 UI

Tutorials: 8 UI

Tests: 2 UI

1. Combustion phenomenology.
2. Balance equations.
3. Combustion thermochemicals.
4. Reaction kinetic element.

VA GE3 - TURBINE-DRIVEN MACHINES

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know the functioning of turbine-driven machines, their dimensions and performance.

Students know-how at the end of the courses:

This course leads to the study of turbine-driven machines, calculation of compressors and turbines.

Connections with other courses:

This course is part of the modules group "Energy conversion". It is also associated to "Assessment of energy chains" module.

2. DETAILED PROGRAMME

Courses: 14 UI

Tutorials: 8 UI

Tests: 2 UI

1.Reminders on turbine-driven machines.

2.Mechanics elements linked to compressible fluids.

3.Theory of blades grilles.

4.Similarities.

VA GE4 - ADVANCED THERMAL TRANSFERS

Department: Mechanics - energy
Prerequisite courses: Introduction to thermic transfers DM2-HM2
Courses or Modules for which this module is necessary: VAGE5 (Pumps and exchangers) – VAGE7 (digital techniques)
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know heat transfers by conduction in an unsteady system and transfers by convection.

Students know-how at the end of the courses:

They will be able to evaluate heat transfers in a practical case and particularly the application to heat exchangers; to become familiar with analytic and semiempirical methods.

Connections with other courses:

This course is part of the modules group "Energy conversion". It is associated to "Digital techniques" and "Exchangers".

2. DETAILED PROGRAMME

Courses: 14 UI

Tutorials: 8 UI

Tests: 2 UI

1. Conduction in unsteady system: analytic and digital methods.
2. Convection: dimensional analysis, use of experimental correlations, forced and natural convection.

VA GE5 - PUMPS AND EXCHANGERS

Department: Mechanics - energy
Prerequisite courses: Hydraulics DM1-HM1 – VAGE4 (advanced thermic transfers)
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Knowledge in the field of pumps and heat exchangers : functioning, performance, dimensioning.

Students know-how at the end of the courses:

This course leads to the knowledge of main types of pumps and exchangers. It provides bases that are necessary to their dimensioning and the calculation of their performance.

Connections with other courses:

In the extension of courses on hydraulics and thermic transfers, this one enables to understand and study pumps and exchangers that are used in energy facilities and especially leur use in the Navy.

2. DETAILED PROGRAMME

Courses: 14 UI

Tutorials: 8 UI

Tests: 2 UI

Functioning principle and description of the differents types of pumps.

Functioning curbs and applications.

Description of different types of exchangers, their functioning and applications.

Calculation methods : DTLM, NUT ; applications.

VA GE6 – SPEED VARIATION IN ELECTROTECHNICS, ELECTRIC PROPULSION

Department: Mechanics – energy
Prerequisite courses: DM3-HM3 - power electronics
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know how alternative machines with speed variation function and be aware of their application as far as naval propulsion is concerned.

Students know-how at the end of the courses:

Knowledge about alternative machines with speed variation functioning and their application to naval propulsion.

Connections with other courses:

This course is part of the modules group "Energy conversion". It is based on core curriculum courses (Electric and automatic engineering) and courses dedicated to power electronics (optional).

2. DETAILED PROGRAMME

Courses: 12 UI

Tutorials: 7 UI

Tests: 2 UI

1. Interests and constraints of an electric propulsion.
2. Architectures of speed variations based on the use of a direct current machine: connection with association with breaking up systems and rectifiers.
3. General matters on systems using alternative machines for naval propulsion (polyphased machines, double star, use of current commutators or voltageundulators, MLI).
4. Architectures based on the use of a synchrone machine – results and future prospects.
5. Case study on existing systems (military and civilian ships, submarines).

VA GE7 - DIGITAL TECHNIQUES

Department: Mechanics – energy
Prerequisite courses: Advanced thermic transfers
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know digital techniques used for assessing aquations with partial derivatives. Application to thermic transfers problems and approach of industrial calculation codes.

Students know-how at the end of the courses:

This course leads to the resolution of thermic problems and to the acquisition of concepts linked to industrial calculations codes.

Connections with other courses:

This course is part of the modules group "Tools for the Engineer in Energies". It constitutes an application of the courses dedicated to "Thermic transfers" and provides useful tools for in-depth unit projects and final studies projects.

2. DETAILED PROGRAMME

Courses: 10 UI

Practical: 14 UI

Tests: 0 UI

1. Resolution of algebraic systems.
2. Finished differences.
3. Finished volumes.

VA GE8 - ENERGY CHAINS

Department: Mechanics – energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To draw up an appraisal of important energy chains and make cadets aware of their implications. To talk about the choice of energies on a ship and its consequences.

Students know-how at the end of the courses:

This course leads to a general learning on great energy connection and their implications.

Connections with other courses:

This course is divided into 3 parts. The first one is made of general matters on energy consumption and production ; it constitutes an introduction to the whole VA GE. The 2 other parts are syntheses applied to the specific case of the navy and they deal with electric ship and nuclear energy issues.

2. DETAILED PROGRAMME

Courses: 18 UI

Tests: 2 UI

1. Energy consumption and production, development prospects, resources and environment.
2. All-electric ship.
3. The production of nuclear energy in the navy.

VA GE9 - METALLURGY

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

To know the bases of metallurgy so as to understand metals' behaviours and features.

Students know-how at the end of the courses:

Metals' structure, treatment and features.

Connections with other courses:

This course is part of the modules group "Tools for the engineer in energy". It is an application of the concepts of atomistic chemicals of which it provides some reminders.

2. DETAILED PROGRAMME

Courses: 12 UI

Tutorials: 7 UI

Tests: 2 UI

1. Atomistics.
2. Cristallography.
3. Mechanic features of metals.
4. Treatments.
5. Corrosion.

VA GE 10 - PROJET VA GE

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

   Apply learning acquired during the VA GE within a scientific project.

2. DETAILED PROGRAMME

   Practical: 42 UI for the project
   Tests: 6 for oral presentations

AUDITOR syllabus – PROFESSIONAL MASTER

MODULE "OBJECT-ORIENTATED TECHNOLOGY"

Department: Computer science
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1

1. COURSE OBJECTIVE

Introduction to object-orientated technology concepts. Visual C++ programming.

Students know-how at the end of the courses:

Cadets will know the object-orientated paradigms: classes, polymorphisms, inheritance, etc… Those will be used through the Visual C++ language. Other advanced concepts issuing from the C++ language, such as plot markers will also be approached.

Connections with other courses:

This course presents the power of object-orientated languages in comparison with procedural languages. Object-orientated programming and modelling are used again for tutorials that are part of the Master's modules (Computer graphics) but also within various projects.

2. DETAILED PROGRAMME

Courses: 6 UI

Tutorials : 11 UI

Tests : 1 UI

1. Reminder on procedural programming (1h C)
2. Plot markers (1h C and 4h TD)
3. The object (1hC)
4. Classes (1h C and 3h tutorials)
5. Inheritance, operator surdefinition and access control (2h C and 4h tutorials)

MODULE " EMBEDDED NUCLEAR POWER"

Département : Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1

1. COURSE OBJECTIVE

Basic knowledge on the functioning of a PWR type nuclear reactor, the reactors loading and security constraints.

Students know-how at the end of the courses:

Basic elements (material structure, radioactivity, fission,…), concept of nuclear power security, embedded nuclear system.

2. DETAILED PROGRAMME

Courses: 18 UI

Tests: 1 UI

1. Nuclear physics.
2. Conference on security-reliability.
3. Conference on embedded nuclear power.

MODULE "ENERGY-ELECTRIC PROPULSION"

Department: Mechanics - energy
Prerequisite courses: TC8 (BTS)
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1

1. COURSE OBJECTIVE

To understand and study propelling systems on military or merchant ships as well as their functioning.
Course on the speed variation systems of electric machines.

Students know-how at the end of the courses:

To understand and study propelling systems on military or merchant ships as well as their functioning.

Connections with other courses:

This course is part of those on "Energy conversion" and "Electrical Engineering".

2. DETAILED PROGRAMME

Courses: 8 UI
Tutorials: 6 UI
Tests: 1 UI

1. Introduction and general matters.
2. Architectures based on the use of machines functioning with direct current.
3. Architectures based on the use of synchrones and asynchrones alternative machines.
4. Appraisal and future prospects.
5. Case study.

MODULE "NAVAL HYDRODYNAMICS"

Department: Mechanics - energy
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

This course presents the practical elements that determine a ship head resistance and the features of a screw.

Students know-how at the end of the courses:

Knowledge of rough estimates linked to the implementation of important efforts. This also concerns methods and practical means that determine a ship head resistance and the features of its screw in the framework of a ship project.

Connections with other courses:

This course is connected to those dealing with the ship. It must occur, as far as possible, after a course dedicated to general mechanics of fluids.

2. DETAILED PROGRAMME

Courses: 10 UI

Tutorials: 10 UI

Tests: 1 UI

1. Head resistance.
   - General matters on head resistance.
   - Projection of resistance starting from trials on a model.
   - Rough estimations.
   - Viscous drag.
   - Waves drag.
   - Applications.
2. Propulsion.
   - Screw environment and geometric description.
   - Screw functioning, dimensional analysis, similarity factors and typical curbs.
   - Optimal screw (wake, suction).
   - Other propulsion systems.

MODULE "MANOEUVRABILITY"

Department: Mechanics - energy
Prerequisite courses: Knowledge of hydrodynamics
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Know the basic principles of holding at sea and ships manoeuvre.

Students know-how at the end of the courses:

Know the main features of ships movements and the physical factors that influence them. Implement a simulation software dedicated to ships behaviour.

Connections with other courses:

This course completes those on propulsion and head resistance. It must come after the general hydrodynamics course.

2. DETAILED PROGRAMME

Courses: 10

Tutorials: 6

Practical: 6

Tests: 2

1. General matters – movement equations.
2. Swell.
3. Transversal movements: the rolling.
4. Longitudinal movements: pitching – heaving.
5. Manœuvre.

MODULE "AUTOMATIC SYSTEMS"

Department: Signals and Acoustic
Prerequisite courses: automatic engineering basis
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1

1. COURSE OBJECTIVE

This learning constitutes a natural consequence to the core curriculum course "Serial automatic systems". It provides the analysis and stability methods of a system based on an automatic control. The concept of corrector is also presented.

Students know-how at the end of the courses:

Cadets will have to be able to notice and study the features of a system based on automatic controls, i.e. static and dynamic precision, stability and speed.

Connections with other courses:

This course requires the cadets to know basic tools and definitions of automatics (Laplace integrals, transfer function, open/closed loop),

2. DETAILED PROGRAMME

Courses: 11

Tutorials : 11

Tests: 2

1. Reminders (Laplace integrals/response of a linear system) (3h)
2. Precision of an automatic control (2h)
3. Stability (3h)
4. Correctors (3h)

MODULE "SIGNALS AND SYSTEMS"

Department: Signals and Acoustic
Prerequisite courses: TNS
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Presentation of the internal architecture of a SONAR. Study of the different fields of signal processing that are necessary to understand the functioning of a SONAR. Introduction to random signals and sensing theory. Screening principles and techniques. Introduction to antennas processing.

Students know-how at the end of the courses:

The internal architecture of a SONAR and the functioning principles must be known. Students will also have to acquire antennas processing and sensing bases.

Connections with other courses:

The global course on sub-marine acoustics is made of three parts: signal processing bases (core curriculum), courses on signal digital processing and submarine acoustics during the 1st semester of the master and then SONAR courses, signals and systems at the second semester.

2. DETAILED PROGRAMME

Courses: 12

Tutorials: 10

Tests: 2

1. SONARS presentation.
2. Internal architecture (emission).
3. Introduction to random signals and screening.
4. Internal architecture (reception) : analog and digital processing.
5. Sensing/assessment (presentation of COR curbs).
6. Transducers and antennas processing.
7. Example: lateral sonar.

MODULE "SONAR"

Department: Signals and Acoustic
Prerequisite courses: TNS, waves spreading, signals and systems
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

The course objective is to integrate various elements studied in the other courses of sub-marine acoustics training (waves spreading, signal digital processing, signals and systems) into the sonar system global analysis. After reminding a few elements of the information chain , essential complementary ideas are presented: noises in the ocean, absorption, target indexes. In the end, all these concepts are gathered within the Sonar's equation which makes it possible to analyse the functioning of a given system and to foresee its performance.

Students know-how at the end of the courses:

Students will have to be able to write down the equation of a sonar belonging to a particular system and to solve it.

Connections with other courses:

This course puts an end to the overall sub-marine acoustics training. Therefore, it takes place after the courses linked with signal digital processing, waves spreading and signals and systems.

2. DETAILED PROGRAMME

Courses: 12

Tutorials: 10

Tests: 2

1. Introduction.
2. Ocean acoustic.
3. Reflection and target indexes.
4. Sonar equation.

MODULE "COMPUTER GRAPHICS"

Department: Computer science
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1

1. COURSE OBJECTIVE

Provide students with computer graphics bases. Students are made aware of modelling techniques and 3D scenes display. One of the application that is mentioned during the course concerns geographic information management in a maritime context.

Students know-how at the end of the courses:

Students will be able to reuse the design process of 3D scenes and their projection in 2D (display on screen). Concerning scenes design, students will have studied 3D objects modelling , the various geometric transformations and lighting processes. As for display , they will have learned different projection modes (perspective and parallel). Those concepts will have been illustrated by tutorials in C/C++ language (by using OpenGL graphic library).

Connections with other courses:

Connections will be set up with the module on geographic information systems (complementarity of these two courses, scenes and data files importation and exportation).

2. DETAILED PROGRAMME

Courses: 6

Tutorials: 9

Tests: 1

1. Introduction.
   2D and 3D geometry.
   Introduction to OpenGL.
2. Geometric transformations.
   Projections.
3. Lighting.
   Colour and texture.

MODULE "GEOGRAPHIC INFORMATION SYTEMS"

Department: Computer science
Prerequisite courses: Databases
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 1,5

1. COURSE OBJECTIVE

Techniques for integrating geographic data, GPS, mobile geographic information systems, techniques for structuring spatial information (raster and vector), topology, quality of geographic data, mistakes management, spatial analysis, mapping, display.

Students know-how at the end of the courses:

At the end of this course, students will be aware of the role and interest of geographic information systems regarding the observation and management of the territory. The acquired techniques cover a good knowledge of geographic information integration and processing techniques as well as their interest in a maritime context.

Connections with other courses:

Strong connection with the course dedicated to databases which constitutes a prerequisite to modelling techniques and data.

2. DETAILED PROGRAMME

Courses: 8

Tutorials: 14

Tests: 2

1. Introduction to geographic information systems.
2. Geographic information integration techniques.
3. Geographic information structuring and data quality.
4. Spatial analysis and cartography.
5. Geographic information systems application.

MODULE "PROJECT OF SPECIALITY"

Department: Professional master
Prerequisite courses: None
Courses or Modules for which this module is necessary: None
Number of ECTS credits: 3

1. COURSE OBJECTIVE

   Apply the whole learning that was acquired during the in-depth units.

2. DETAILED PROGRAMME

   Tutorials: 42
   Tests: 6